PATENT

SPECIFICATION

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# EMISSION CONTROL DEVICE AND METHOD

## CROSS REFERENCE TO RELATED APPLICATION

~~This application is a continuation-in-part of U.S. Serial No. 09/858,129, filed May 15, 2001, which claims the benefit of the divisional of co-pending U.S. Application No. 09/809,990, filed March 16, 2001.~~

## FIELD OF THE INVENTION

The present invention relates generally to an apparatus and method for treating exhaust gases, and more particularly to a combustion engine treatment device for removing and/or reducing pollutants contained in the combustion engine effluent gases. In particular, the present invention reduces carbon dioxide, substantially reduces hydrocarbons and nitrous oxides, and virtually eliminates the exhaust of carbon monoxide from those gases in the exhaust stream. More particularly, the invention relates to an induction coil used to deliver voltage to the treatment device.

## BACKGROUND OF THE INVENTION

With the increasing use of automobiles, trucks, aircraft, and other combustion engine vehicles, growing concern over the gaseous pollutants emitted by these sources is justifiably mounting. Carbon monoxide, the toxic by-product of incomplete combustion, is a major contributor to air pollution and poses a very real threat to public health. Carbon dioxide, although non-toxic, is recognized as an air pollutant that directly causes the "greenhouse effect." Modern fuels generate excessive amounts of carbon dioxide which scientists report are contaminating the atmosphere worldwide. Additionally, today's engines also generate an unhealthy amount of toxic hydrocarbons which are generally responsible for eye irritation, nasal congestion and breathing difficulties.

In addition to the problems caused by exhaust emissions from combustion engines, significant exhaust pollution is also created from industrial effluent stacks as exemplified in spray booths, styrene manufacturing and the burning of hazardous waste, among a variety of industrial processes.

Numerous devices and methods are known in the art for the control of exhaust gas contaminants. Among those methods, electrostatic precipitation is widely used in such applications and involves the application of high voltages to electrodes positioned in the exhaust gas stream. This process induces ionization of gas particles which in turn causes particulates suspended in the gas to

acquire a charge from contact with the ionized gas particles. The charged particles are then collected at oppositely charged diodes which must be eventually "cleaned" or "scrubbed". A significant drawback of electrostatic precipitation is that only a small amount of particulate matter can be precipitated out of the exhaust stream. The process is ineffective at removing gaseous contaminants such as carbon monoxide and carbon dioxide.

Burners, activated carbon and water curtains are also widely used to reduce hydrocarbon and volatile organic compound emissions. However, these pollution control devices are impractical for use with internal combustion engines. Additionally, a significant drawback of burners and water curtains is a large operational cost and activated carbon is easily clogged when treating a particulate laden air stream.

In the automobile industry, in efforts to meet increasingly more stringent vehicle emissions standards, some manufacturers have begun using multiple catalytic converters on their vehicles. However, the conventional catalytic converter is expensive to manufacture since platinum, palladium or rhodium is used in its manufacture.

A recent innovation in reducing emissions from an exhaust stream is to generate an electrical charge within the exhaust stream. However, several technical problems are associated with creating the electrical charge. Firstly, a high voltage must be applied to the exhaust stream to create the

electrical charge. Standard wiring is not well-suited to deliver the necessary voltage since such wiring is subject to significant voltage loss. Secondly, high voltage supplied through standard wiring can cause random cycling frequencies in adjacent wiring. When occurring in automotive wiring, the random cycling frequencies can be sufficiently large to set false codes in the automobile's computers or even damage the computers. Thirdly, the electrical charge must be sufficiently distributed over the entirety of the exhaust stream to properly treat the exhaust stream.

## DESCRIPTION OF THE PRIOR ART

Applicant is aware of the following U. S. Patent:

| U.S. Pat. No. | Inventor | Issue Date | Title |
|---|---|---|---|
| 5,419,123 | Masters | 05-30-1995 | EMISSION CONTROL DEVICE AND METHOD |

Masters, U.S. Patent 5,419,123, discloses an emission control device and method for treating exhaust gases to reduce pollutants contained therein. The device includes a treatment chamber having a first metal screen, a second metal screen and a perforated chemical substrate disposed between the first and second metal screens. An electrode is disposed a distance from the first screen. Voltage is applied to this electrode so that sparks are generated between the electrode and the first screen.

Although the Masters patent may reduce emissions in the exhaust stream, it has several limitations. Firstly, a plug is used to deliver the spark. This area of the plug is concentrated to a portion of the first screen and hence is not evenly distributed over the entirety of the screen. Consequently, a portion of the exhaust stream is not sufficiently treated under this method. This problem becomes more pronounced if the plug becomes angled towards or away from the first screen.

Secondly, since the voltage is applied to the plug via standard wiring, there are significant losses such that only about thirty percent (30%) of the voltage generated is actually applied to the plug. Accordingly, for 15,000 volts to be delivered to the plug, about 50,000 volts must be supplied. This high voltage is particularly problematic when used with an automobile since it can cause random cycling frequency in the automobile's circuitry sufficient to send false codes to the automobile's computers or even damage the computers.

Thirdly, by placing the first and second screens on opposite sides of the strata, sparks are not generated between the screens.

## SUMMARY OF THE INVENTION

The present invention provides a superior apparatus and method for reducing or eliminating emissions from a gas stream. The gas stream is treated by a treatment chamber in series with a second chamber having perforated strata. The treatment chamber includes an insulated first metal grid supplied with high voltage and a second metal grid that is grounded to the treatment chamber to generate an electrical charge over the entirety of the first grid to the second grid thereby causing electronic ionization. Since all of the gas stream is required to flow through the first and second grids, all of the gas stream is fully treated.

The second metal grid is conductively connected to the second chamber containing strata and, therefore, the entire connection and the second treatment chamber are also electronically ionized. Due to the treatment caused by a more complete electronic ionization, the strata can more fully perform its function with significantly less use of noble metals than with a conventional catalytic converter. Although maximum pollution reduction occurs with the use of about one tenth (1/10) of a troy ounce of platinum, rhodium, or palladium per converter, favorable results can also be achieved without using noble metals whatsoever.

A further advance, in the form of a special electrical cable, is a high efficiency induction coil. This induction coil applies voltage from a power coil to the insulated first metal grid at an efficiency

of at least eighty percent (80%) thereby generating a very hot electrical charge between the first grid and the second grid. This induction coil is further configured to dampen the magnetic field created by the induction coil. Dampening the magnetic field is particularly important in automotive applications and other applications which are integrated with computers since the magnetic field can create random cycling current in the electrical system causing false signals to be sent to the automotive computers.

The induction coil can also be used in place of a spark plug wire. Since the induction coil allows for a very hot spark, the power stroke of a piston is more efficient thereby yielding greater gas mileage.

Yet another advance is that the present invention reduces carbon dioxide, substantially reduces NOx and hydrocarbons, and virtually eliminates the exhaust of carbon monoxide. The invention can be used to treat emissions from industrial effluent stacks, spray booth, styrene manufacturing, the burning of hazardous waste and purifying air streams among a variety of other industrial processes. It is particularly useful for treating emissions from the combustion of all carbon or fossil fuels. The system can be installed as original equipment, as an add on device or as an after market device.

## OBJECTS OF THE INVENTION

The principal object of the present invention is to provide an improved apparatus and method for reducing pollutants from an exhaust stream. The apparatus includes a first body forming a first chamber. The first and second metal grids are fixed within the first chamber so that the exhaust stream entering the first chamber passes through the grids. An electrical connector is attached to either the first grid or the second grid and connects that grid to a voltage source causing an electrical charge to be generated between the first grid and the second grid. A pulsing mechanism pulses the applied voltage at a predetermined frequency. A second body forming a second chamber has perforated strata through which the exhaust stream flows.

Another object of the invention is to provide a voltage difference between the first grid and the second grid of at least 20,000 volts. The grid receiving the voltage is insulated from the first body while the other grid is grounded. Additionally, the pulsing mechanism is capable of pulsing the voltage at a frequency of greater than 1,600 pulses per minute.

A further object of the present invention is to fix the nearer of the first or second grid a distance between about 2.54 centimeters (1 inch) and 30.48 centimeters (12 inches) from the strata. Additionally, another object is to space the first grid from the second grid a distance between about 0.635 centimeter (1/4 inch) to 2.54 centimeters (1 inch).

Another object of the present invention is to provide an electrical connector which includes a plurality of bare wires juxtaposed in a first curvilinear row and coiled equal-distantly about a curvilinear centerline thereby forming a curvilinear helix. An insulated center core is positioned along the curvilinear centerline and disposed within the bare wires and the insulated wires.

A further object is for the electrical connector to include three or more bare wires.

A still further object is for the electrical connector to include a plurality of insulated wires juxtaposed in a second curvilinear row and coiled around the bare wires.

A further object is for the electrical connector to use four or more bare wires and three or more insulating wires.

Still another object of the present invention is to use an electrical connector which is adapted to apply at least eighty percent (80%) of the voltage the connector receives.

Another object of this invention is to provide a method of treating an exhaust stream to reduce pollutants contained therein. The method includes the steps of passing the exhaust stream through a first body forming a chamber. The exhaust stream is passed through a first grid and a second grid fixed within the chamber. The grids are separated a predetermined distance from each

other. Voltage is supplied from a voltage source to either the first or the second grid to generate an electrical charge between the first grid and the second grid. The voltage is pulsed at a predetermined frequency. The exhaust stream further passes through a strata.

A further object of the invention is to provide a voltage difference between the first grid and the second grid of at least 20,000 volts at a frequency of at least 1,600 pulses per minute. The voltage receiving grid is insulated from the first body while the other grid is grounded.

## BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects will become more readily apparent by referring to the following detailed description and the appended drawings in which:

Figure 1 is a diagrammatic view of an embodiment of the present invention shown in use as an emission control device;

Figure 2 is a perspective view shown in partial cut-away of a induction coil;

Figure 2a is a perspective view of a detail showing the induction coil of Figure 2;

Figure 3 is a perspective view shown in partial cut-away of a treatment chamber;

Figure 4 is a perspective fragmentary view taken along line 4-4 of Figure 1 showing a second chamber having a strata;

Figure 5 is a perspective view shown in partial cut-away showing an alternative embodiment of the second chamber having baffles; and

Figure 6 is a perspective view shown in partial cut-away of an alternative induction coil.

## DETAILED DESCRIPTION

Figure 1 generally illustrates a system 10 for treating an exhaust stream by reducing pollutants contained therein. The system 10 includes a power coil 12, an induction coil 14, a first chamber 16 and a second chamber 18.

Per Figure 3, the first chamber 16 includes a continuous outer wall 20, an intake end 22 and an exhaust end 24. An insulated first metal grid 26 is disposed within the treatment chamber and separated from the outer wall 20 by an insulator 28. A grounded second metal grid 30 is disposed within and attached to the treatment chamber 16 a predetermined distance from the insulated first

metal grid 26. The power coil 12 is connected to the insulated first metal grid 26 via the induction coil 14. A frequency mechanism 32 is provided for pulsing the voltage supplied to the insulated first metal grid 26 at a predetermined optimum frequency depending upon the application.

The induction coil 14 shown in Figures 2 and 2A is configured for use with automotive applications and other applications which are integrated with computers. The induction coil 14 is highly efficient and capable of delievering at least eighty percent (80%) of the supplied voltage to the insulated first grid 26. Moreover, the induction coil 14 dampens its own magnetic field and, consequently, abates creation of random cycling current in the electrical system which otherwise could cause false signals to be sent to the automotive computers.

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The induction coil 14 comprises an insulated center wire 34, a plurality of bare wires 36 juxtaposed in a row and a plurality of insulated wires 38 juxtaposed in a row. The insulated wires 38 are wrapped throughout the length of the bare wire 36 cluster, and the combination thereof is wrapped throughout the length of the center wire 34. An insulating sheath 39 is disposed about the induction coil 14 to protect and maintain the integrity of the coil 14. Although any number of arrangements are possible, preferably the insulated wires 38 are a group of three or more, and three or more wires comprise the cluster of bare wires 36. More preferably, the induction coil 14 includes three insulated wires 38 and four bare wires 36. A metal eyelet can be provided to ground the induction coil 14. The wires 34, 36, 38 are standard wires and preferably made of silicon or copper.

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~~For example, in the preferred embodiment, the center wire 34 is a standard 8 millimeters plug core and made of silicon, the bare wires 36 and the insulated wires 38 are 18 gauge copper wires.~~

An alternative induction coil 60 is shown in Figure 6. The induction coil 60 includes an insulated center wire 62, a plurality of bare wires 64 juxtaposed in a row and wrapped throughout the length of the center wire 62. An insulating sheath 66 is disposed about the induction coil 60 to protect and maintain the integrity of the coil 60. Although any number of arrangements are possible, preferably three or more wires comprise the cluster of bare wires 64. A metal eyelet can be provided to ground the induction coil 60. The wires 62, 64 are standard wires and preferably made of silicon or copper. For example, in the preferred embodiment, the center wire 62 is a standard 8 millimeter plug core made of silicon, and the bare wires 64 are 18 gauge copper wires.

As with the induction coil 14, the alternative induction coil 60 is capable of delivering at least eighty (80%) of the supplied voltages. However, since the induction coil 60 does not include a plurality of insulated wires, the alternative induction coil 60 has limited ability to dampening the associated magnetic field. Consequently, the alternative induction coil 60 can be used for automotive spark plug wire or for wiring in two cycle engines, but not for wiring which would cause random cycling frequencies in another wire sufficient to disrupt computer equipment.

As shown in Figure 1, the first chamber 16 is a segment of an exhaust conduit 40. Preferably the first chamber 16 is upstream of the second chamber 18. The first chamber 16 can also be placed generally anywhere in-line in the exhaust system such as, for example, after the second chamber 18. However, such positioning is less efficient in pollution reduction.

Referring to Figure 3, the first chamber 16 is preferably cylindrical and formed of metal. The first and second metal grids 26, 30 are perpendicular to a central axis 41 of the first chamber 16. The grids 26, 30 have a meshed pattern and completely fill the cross-sectional area of the first chamber 16 so that all of the exhaust passes therethrough. The first grid 26 is insulated from, and secured to, the continuous wall 20 by any conventional means 28. The grounded second grid 30 is conductively secured to the continuous wall 20 by any conventional means such as welding. It is preferred that the grids 26, 30 are fabricated from chromium, stainless steel or magnesium alloy, however, other conductive compositions can also be used. The induction coil 14 passes through the continuous wall 20 and attaches to the insulated first grid 26 to directly apply voltage thereto. When voltage is applied to the insulated first grid 26, the entire first grid 26 is placed at the supplied voltage potential causing electrical charges to be generated across the gap between the insulated first grid 26 and the grounded second grid 30. Although the first grid is shown upstream of the second grid 30, this positioning can be reversed.

As shown in Figures 1, 4 and 5, the second chamber 18 is preferably cylindrical and has a metal shell 42. The second chamber 18 includes a proximal diffusion end 44, a central portion filled with strata 46 and a distal end 48 for exhausting the treated exhaust. The strata 46 can be formed of silica or metal having between 7.9 holes per centimeter (20 holes per inch) and 157.5 holes per centimeter (400 holes per inch) to allow the exhaust stream to flow therethrough. Larger holes 50 are preferred when treating heavier flows such as emissions from a diesel engine while smaller holes 50 are used with lighter emissions. Preferably, the holes 50 are generally linear and parallel with a central axis of the second chamber 18. However, a honeycomb strata can be used. Typically the strata 46 will contain about one-tenth (1/10) of one troy ounce or less of noble metals such as palladium, platinum or rhodium depending upon the application. Alternatively, the strata can be formed without noble metals.

As shown in Figure 5, the distal end 48 can be provided with a series of baffles 52 which muffles sound and can serve to replace a standard muffler depending upon the application.

Referring to Figure 1, in operation the pollutant laden exhaust stream flows through the exhaust conduit 40 into the first chamber 16 through the intake end 22, passes through the insulated first grid 26, then through the grounded second grid 30 before exiting the exhaust end 24. A predetermined distance between the first and second grids 26, 30 typically ranges from 0.635 centimeter (1/4 inch) to 2.54 centimeters (one inch) depending on the voltage of the first grid 26.

In general, the grids 26, 30 are spaced a distance of 0.318 centimeter (1/8 inch) for the first 20,000 volts and then an additional 0.318 centimeter (1/8 inch) for each 10,000 volt increment. The first chamber 16 can be located anywhere in-line in the exhaust system but generally is placed between 2.54 centimeters (one inch) and 30.48 centimeters (12 inches) from the second chamber 18 depending upon the application.

Any power coil and pulsing mechanism sufficient to supply the necessary voltage at the proper frequency can be used. The applicant has determined that a voltage of at least 20,000 volts at a pulse rate of at least 1,600 pulses per minute is preferred for optimizing the reduction of carbon monoxide, hydrocarbons and NOx depending on the exhaust stream being treated. Typically the voltage will be in the range of 40,000 to 100,000 volts and the pulse rate will be in the range of 1,600 to 10,000 pulses per minute. In general, wetter exhaust such as the exhaust from a diesel internal combustion engine requires higher voltage and pulse frequency than emissions from lighter fuels such as unleaded gasoline or propane. For example, with a gasoline powered automotive internal combustion engine, an output between 40,000 to 60,000 volts at 2,000 to 5,000 pulses per minute is preferred for optimizing reduction of carbon monoxide, hydrocarbons and NOx depending upon the application. The voltage and frequency are also set in proportion to the displacement of the engine with the upper values more suitable for larger engines.

A power coil 12 can be any voltage source that provides the predetermined voltage. A pulsing mechanism can be any device which sets the voltage at the proper frequency. As an example, and not to so limit the present invention, Figure 1 illustrates that the power coil 12 can comprise a voltage box 54 and an automotive battery 56. The primary windings of the voltage box 54 is supplied with approximately three (3) amperes from a twelve volt automotive battery 56 and outputs 40,000 volts to the induction coil 14 at a pulse rate of about 2,500 pulses per minute depending upon the application. As a further example, small engines, such as two cycle engines can have a dual magneto that can supply voltage at the proper frequency to the first grid 26 by the magneto without use of a battery or voltage box.

The inventive induction coil 14 is configured to deliver at least eighty percent (80%) of the voltage to the insulated first grid 26 and to dampen the magnetic field created by the induction coil 14 itself. Measured on an alternating current scale, this dampening effect caused by the induction coil 14 avoids creating radio frequency interference (cycling frequency) greater than 0.4 volts in the induction coil 14 itself, and preferably less than 0.4 volts in the adjacent wiring.

Per Figure 2, current supplied through the core wire 34 creates a magnetic field. Per Figure 2a, this magnetic field is dampened by the combination of copper wires 36 and the insulated copper wires 38. Dampening the magnetic field is particularly important in automotive applications and other applications which are integrated with computers. This is true since an undampened magnetic

field can create random cycling current in the electrical system and at a level of approximately 0.5 volts false signals are sent to the automotive computers.

While not wishing to be bound to any particular theory, it is believed that exhaust pollutants are treated by electronic ionization at both the chemical and thermal levels. Referring to Figure 1, electronic ionization is caused by supplying voltage at a frequency to the insulated first grid 26. Electronic ionization occurs between the first and second grids 26, 30. Additionally, the exhaust conduit 40 and second chamber 18, including the strata, 46 are ionized. Since the insulated first grid 26 receives the entire exhaust stream and the voltage is supplied to the entirety of the insulated first grid 26, all of the exhaust is fully treated by electronic ionization.

Exhaust exiting the first chamber 16 enters the second chamber 18 and passes through the strata 46. The second chamber 18 treats the ionized exhaust stream by use of a catalyst in addition to electronic ionization. Presently, the preferred strata 46 contains about one-tenth (1/10) of one troy ounce of noble metals such as, for example, platinum, palladium or rhodium which serve as a catalyst. The catalyst oxidizes carbon monoxide and hydrocarbon pollutants to form carbon dioxide and water. The catalyst also oxides NOx to form nitrogen and oxygen. The strata 46 also has the benefit of producing free radical molecules of oxygen ($O_2$) during operation of the emission control system 10. Ozone ($O_3$) is created at the first grid 26 and the strata 46 oxidizes that ozone to generate oxygen therefrom.

Alternatively, the strata in the second chamber 18 can be made of metal or silica. The applicant has found that the pollutant removal efficiency of the system 10 without noble metals is comparable to that of current catalytic converters. Although the present invention can be used with a standard catalytic converter, the reduction or elimination of noble metals from the second chamber 18 provides significant cost savings.

Another important benefit of the present invention is its extremely short start-up time. The system 10 can be at full operating condition in as little as twenty to thirty seconds depending upon the application. For automotive use, voltage is supplied to the insulated first grid 26 in the first chamber 16 as soon as the ignition is turned to the "key-on" position thereby generating an electrical charge before exhaust is generated. Furthermore, although higher temperatures can be used, the second chamber 18 fully operates at low heat typically in the range of 64°C (160°F) to 93°C (200°F) as measured at the outside shell 42. This shell temperature correlates to an exhaust temperature of approximately 204°C (400°F). Conventional catalytic converters take four or five minutes of engine warm-up time to reach operating temperatures of about 316°C (600°F) at the outside shell and 982°C (1800°F) internally. Since the system 10 operates at relatively low heat, extensive heat shielding is not required for the second chamber 18. Such low heat also reduces the probability of fires as caused by current catalytic converter systems. Additionally, since the system 10 operates independently of the engine, it does not require expensive interactive controls with the engine nor is a thermocouple necessary.

Although the present invention has been explained primarily in use with an automobile, the present invention is not limited to such. For example, the system 10 could be mounted to an industrial effluent stack, to an exhaust stack from a spray booth, or to any such variety of other effluent stacks. For such other applications the first chamber 16 could be supplied pulsed voltage from any number of independent sources.

## SUMMARY OF THE ACHIEVEMENT OF THE OBJECTS OF THE INVENTION

From the foregoing, it is readily apparent that I have invented an improved method and apparatus for reducing or eliminating pollutants, including gaseous pollutants, from an exhaust stream.

It is also apparent that the reaction and reduction occurs at the grids and at the catalytic converter that is operable at a relatively low temperature.

It is further apparent that I have invented an improved induction coil which is adapted to apply a greater percent of the voltage the induction coil receives than a standard wire.

It is also apparent that the induction coil dampens the magnetic field about the induction coil such that random cycling frequencies in the adjacent wiring are not created.

It is to be understood that the foregoing description and specific embodiments are merely illustrative of the best mode of the invention and the principles thereof, and that various modifications and additions may be made to the apparatus by those skilled in the art, without departing from the spirit and scope of this invention, which is therefore understood to be limited only by the scope of the appended claims.